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H4D

(54) Aircraft position determination

(57) The position of a helicopter (3) (Fig. 1) is maintained constant by means of signals received by a receiver (4) in the helicopter, from a transmitter 1, Fig. 2 on the ground. The transmitter has three orthogonal coils 10, 11 and 12 that are each energised by alternating signals of different frequency so that each coil propagates radiation at a different frequency over a short distance. The receiver also includes three orthogonal coils (40), (41) and (42) (Fig. 3), the radiation propagated by the transmitter 1 inducing a signal at each frequency in each coil. The receiver 4 measures the relative strength of each signal in each coil and from this computes the position of the receiver relative to the transmitter 1. The helicopter is controlled, on change in position, to restore it to its initial position.

Fig.2.

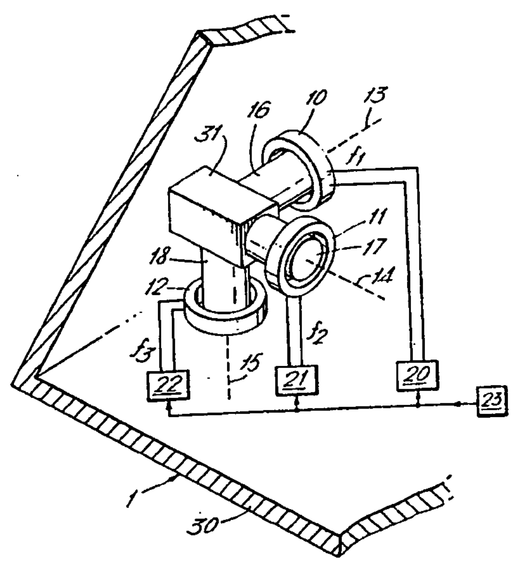

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Fig.1.

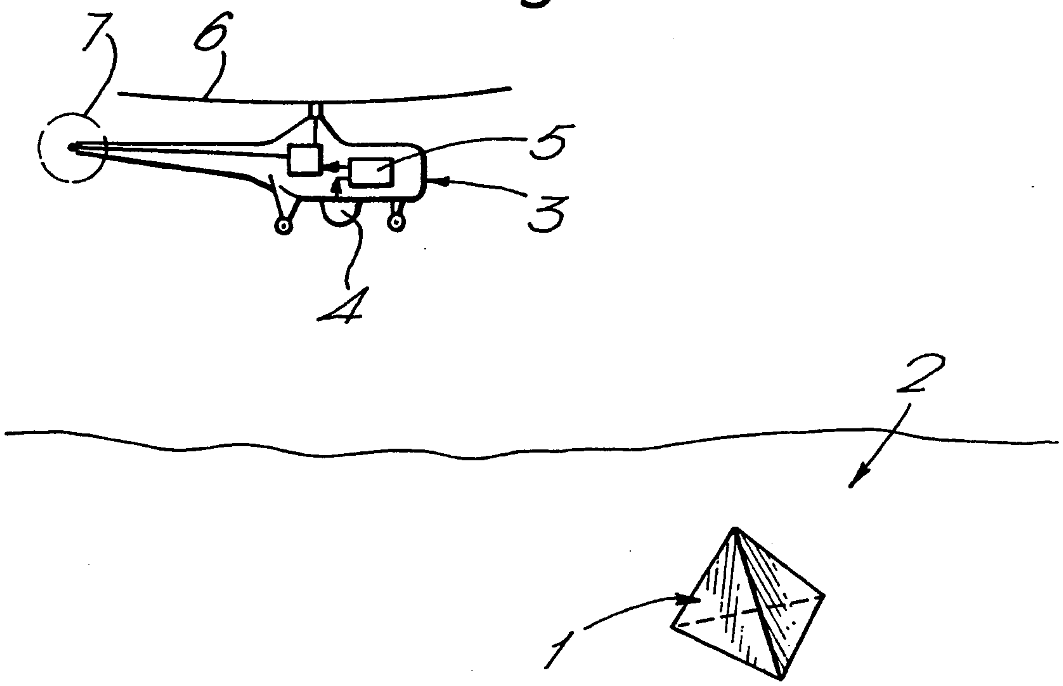


Fig.4.

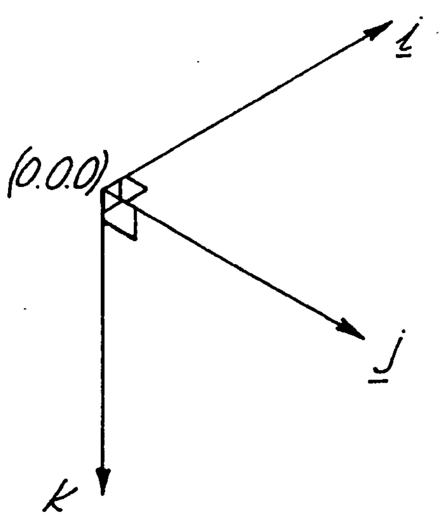


Fig.5.

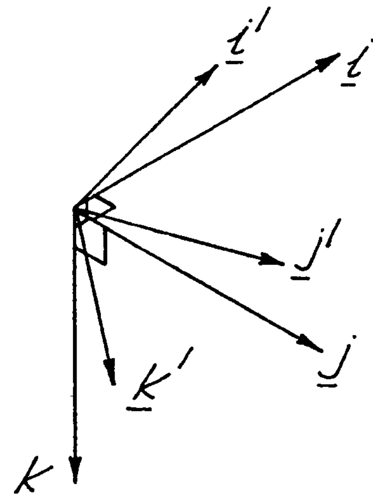


Fig.2.

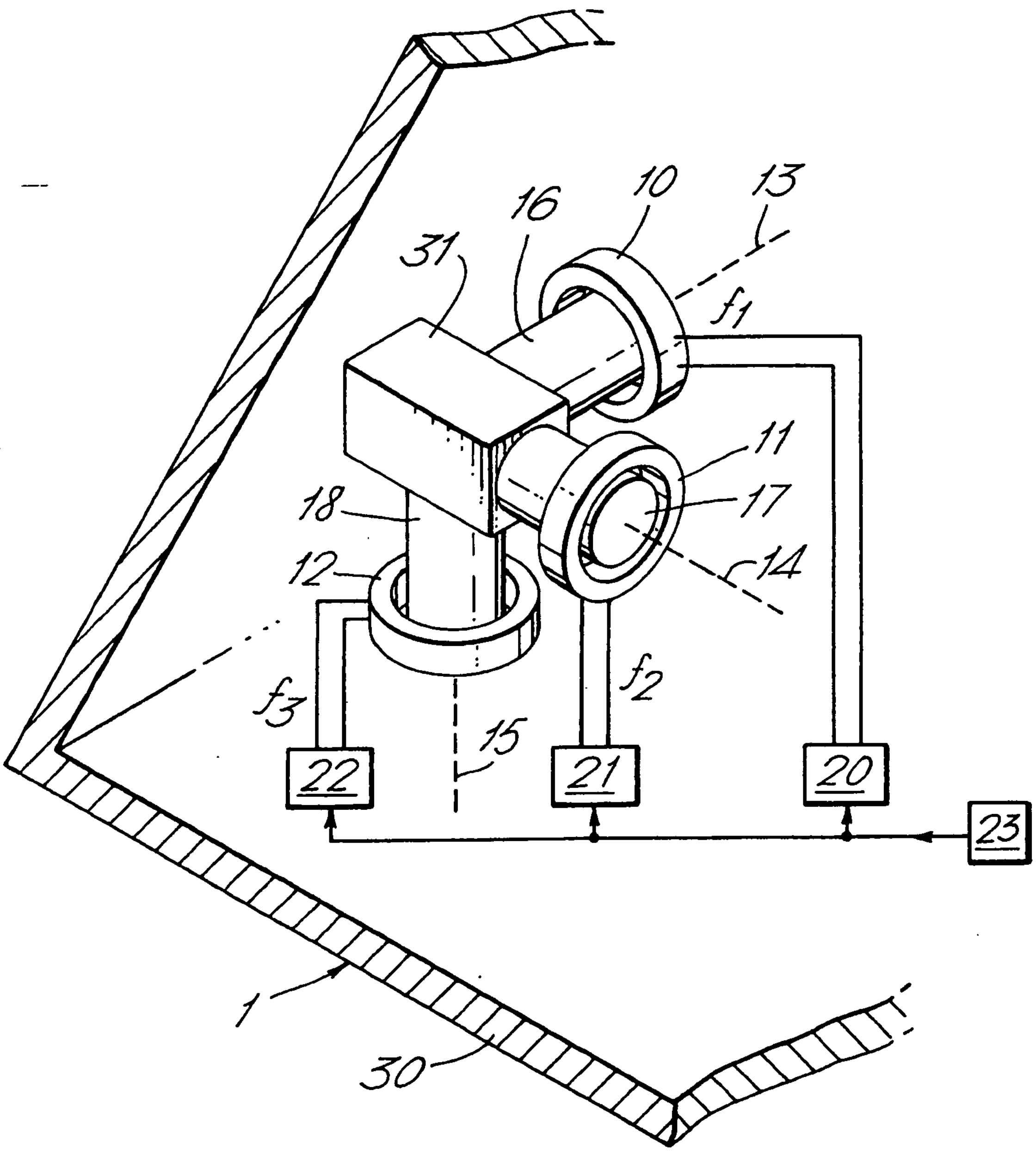
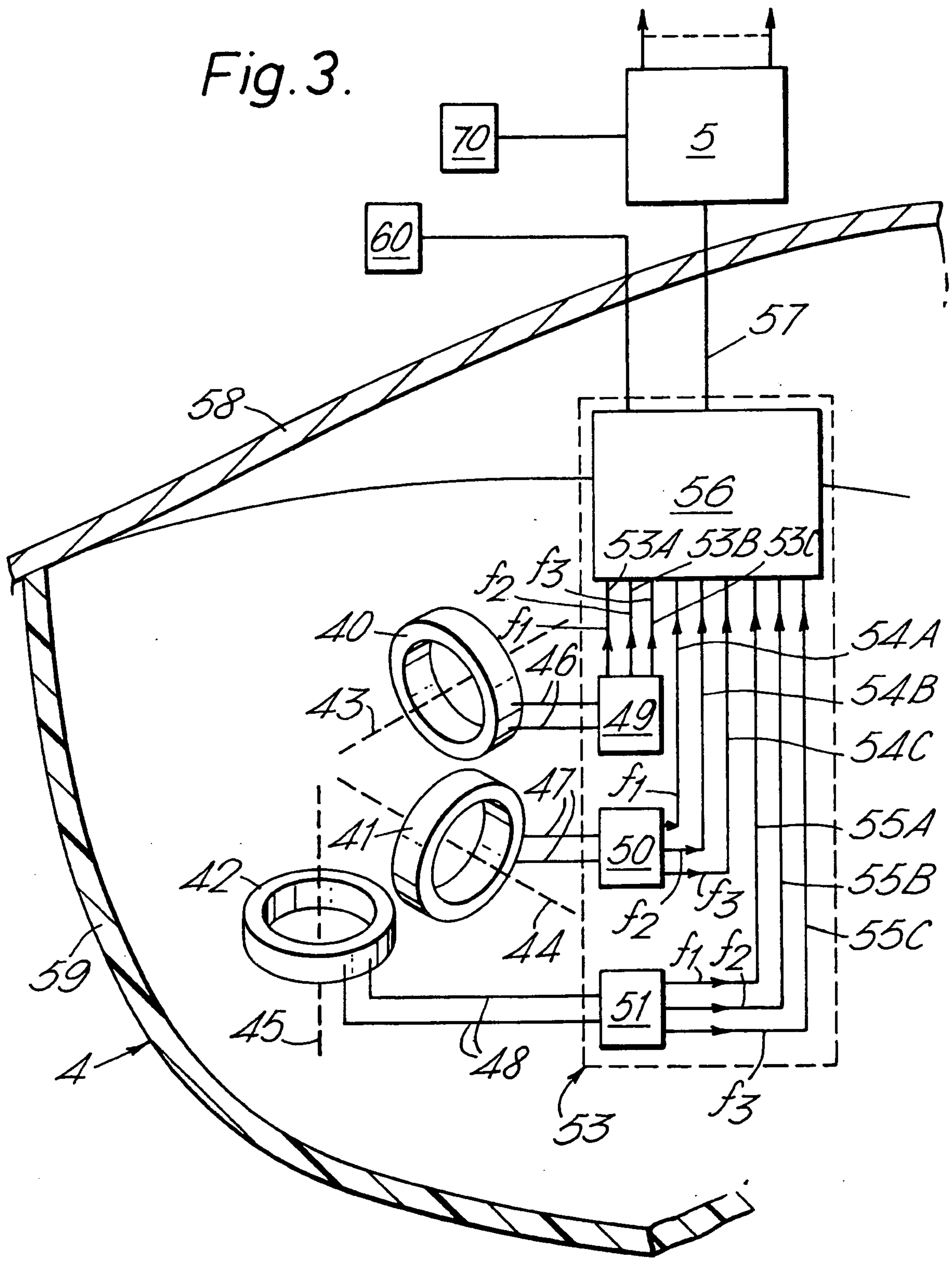


Fig. 3.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SPECIFICATION
Position Determining and Control

This invention relates to position determining systems and to position control systems including position determining systems.

The invention is more particularly, but not exclusively, concerned with systems for maintaining an aircraft, such as, for example, a helicopter, at a constant position with respect to a location on the earth's surface, either on land or water.

It is important in some instances for the position of a helicopter to be maintained constant, this being especially important in surveillance and aerial reconnaissance, in air-sea rescue operations or when the helicopter is used as a stable platform such as, for example, for television cameras. It is not possible merely to lock the controls of the helicopter because wind or other atmospheric conditions, and random changes in power of the helicopter engines will all influence the behaviour of the helicopter.

Several arrangements for maintaining constant position of a helicopter have been considered. For example, the helicopter could be tethered to the ground by a cable, one end of which is secured to the ground and the other end of which is attached to a force measuring sensor which supplies signals to the helicopter's flight control system in accordance with the strain exerted on the cable. In this way, the helicopter can be controlled to maintain a constant strain on the cable. This arrangement, however, has several disadvantages. First, it would be difficult to put into practice at sea because of the problems of anchoring a cable at the water surface. It may also be dangerous to secure a helicopter in this way because it would severely restrict manual control of the helicopter and there would be the risk that a broken cable might become entangled in the rotor blades. There would also be difficulties in maintaining a constant angular orientation of the helicopter with respect to the secured end of the cable.

In an attempt to avoid the need rigidly to tether a helicopter in the above manner, it has also been proposed instead to view the earth's surface with some form of optical sensor, such as a television camera, and to apply correction to the helicopter's controls in accordance with any change in the image received by the sensor arising from movement of the helicopter. This might be done by viewing the normal ground surface or, alternatively, by dropping a coloured or illuminated marker onto the ground into the field of view of the sensor—this alternative arrangement would have special application at night or over regions of unbroken topography such as desert or water. Such an arrangement does have advantages but could be relatively expensive since a complex system would be needed to evaluate changes in the field of view of the sensor. The arrangement would also have disadvantages in low-visibility conditions where the sensor might not have a clear view of the ground. In some cases it might, furthermore, be undesirable to use such a system at night since, by dropping an illuminated marker, the location of the helicopter might become known to hostile forces.

It is an object of the present invention to provide a system for determining position that can also be used to control position and that substantially avoids the disadvantages referred to above.

According to one aspect of the present invention there is provided a system for providing an indication of the position of one location relative to another location, the system comprising transmitting means at said one location and receiving means at said other location, said transmitting means including three electromagnetic coil assemblies and means for energizing each said coil assembly with an alternating signal of a different characteristic, said coil assemblies being arranged to propagate electromagnetic radiation along three respective orthogonal axes, and said receiving means including three electromagnetic coil assemblies mounted with orthogonal axes, and means for measuring the amplitude of the signal of each characteristic induced in each said coil assembly such as thereby to enable an indication of the position of said transmitting means relative to said receiving means to be provided.

According to another aspect of the present invention there is provided a system for controlling the position of an aircraft relative to a surface, the system comprising transmitting means fixed relative to said surface, and receiving means on said aircraft, said transmitting means including three electromagnetic coil assemblies and means for energizing each said coil assembly with an alternating signal of a different characteristic, said coil assemblies being arranged to propagate electromagnetic radiation along three respective orthogonal axes, and said receiving means including three electromagnetic coil assemblies mounted with orthogonal axes, means for measuring the amplitude of the signal of each characteristic induced in each said coil assembly such as thereby to provide an indication of the position of said aircraft relative to said surface, and means for monitoring change in said position and supplying control signals to the flight control system of the aircraft in accordance with change in said position.

Each coil assembly of the transmitting means may be energized with an alternating signal of a different frequency. Each coil assembly of the receiving means may have associated therewith respective discriminator means, each discriminator means providing three sets of output signals in respect of the amplitude of signals received at each frequency. The coil assemblies may be of circular shape. The coil assemblies of the transmitting means may be mounted on a deformable support. The transmitting means may include a housing in which said coil assemblies are contained, the housing may be of a deformable material and may be of substantially tetrahedron shape. The transmitting means may be arranged so that it can float on a water surface and that the coil assemblies are supported above the water surface. The transmitting means may be provided with a keel below the water surface that is

arranged to stabilize the transmitting means. The transmitting means may be arranged to propagate electromagnetic radiation in response to an activating signal from the receiving means.

According to a further aspect of the present invention there is provided a method of providing an indication of the position of one location relative to another, wherein each of three electromagnetic coil assemblies of transmitting means at one location is energized with an alternating signal having a different characteristic such that electromagnetic radiation is propagated along three respective orthogonal axes, so as thereby to induce three signals having said different characteristics in each of three electromagnetic coil assemblies of receiving means at said other location and mounted with orthogonal axes, and measuring the amplitude of each of the signals induced in each said coil assembly such as thereby to enable an indication of the position of said transmitting means relative to said receiving means to be provided.

According to yet another aspect of the present invention there is provided a method of controlling the position of an aircraft relative to a surface, the method including the steps of locating transmitting means on said surface, providing receiving means in said aircraft, energizing each of three electromagnetic coil assemblies in said transmitting mes with an alternating signal having a different characteristic such that electromagnetic radiation is propagated along three respective orthogonal axes, so as thereby to induce three signals having said different characteristics in each of three electromagnetic coil assemblies of said receiving means mounted with orthogonal axes, measuring the amplitude of each of the signals induced in each said coil assembly such as thereby to provide an indication of the position of said aircraft relative to said surface, monitoring change in said position, and supplying control signals to the flight control system of the aircraft in accordance with change in said position.

It has been found that a system according to the present invention remains substantially unaffected by the angular orientation of the transmitting means, which is of particular value when the transmitting means is dropped on to a heavy sea.

A system for maintaining the position of a helicopter relative to the earth's surface, in accordance with the present invention, will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 represents schematically a helicopter hovering above the earth's surface;

Figure 2 represents schematically a transmitting unit;

Figure 3 represents schematically a receiving unit mounted on the helicopter; and

Figures 4 and 5 are vector diagrams of the transmitting and receiving units respectively.

With reference to Figure 1, there is shown a transmitter unit 1 resting on the ground 2, and a helicopter 3 having a receiver unit 4 that supplies signals to a flight control system 5. The flight control system 5 maintains the position of the helicopter 3 constant with respect to the transmitter unit 1 by appropriate control of the helicopter rotors 6 and 7.

With reference now to Figure 2, the transmitter unit 1 includes three electrical coils 10, 11 and 12 having their axes 13 to 15 respectively arranged orthogonally. The coils 10 to 12 are of circular configuration and might typically be 1 cm long, having an outer radius of 5 cm and an inner radius of 4 cm although it will be appreciated that the size of the coils will be dictated by the particular application and the available power supply. The coils 10 to 12 are supported in the orthogonal configuration by non-magnetic cores 16 to 18.

Associated with each coil 10 to 12 there is a respective energizing circuit 20 to 22 that are each powered by a battery unit 23. Each energizing circuit 20 to 22 applies an alternating voltage of frequency f_1, f_2 and f_3 respectively to the coils 10 to 12 so that each coil thereby propagates electromagnetic radiation at a different frequency. The radiation propagated by each coil must be characterised in some way, so that when the radiation is received it can be identifed with a particular coil. It is not, however, essential that the coils be energized at different frequencies, it would instead be possible to modulate each energizing signal in a different manner.

The radiation propagated by the transmitter unit 1 occurs along the axes 13, 14 and 15 of the coils 10 to 12 respectively. For short distances, that is, within several hundred metres, it is the induction field (sometimes called the "near" field) which predominates the transitional field and the radiation field. For example, at a distance of 10 metres from a small coil, typically, the contribution of the induction field to signal strength might be 1 millivolt while that of the transitional field and the radiation field might be 300 nanovolt and 100 picovolt respectively; at a distance of 100 metres the contributions might be: induction field 1 microvolt, transitional field 3 nanovolt, and radiation field 10 picovolt. The signal strength arising from the induction field varies inversely with the cube of the distance away from the coil. The fact that the signal strength is rapidly attenuated with distance means that the system only has application over relatively short distances, since at greater distances interference will become significant. This, however, has an advantage in some applications where it is desirable to remain concealed.

The coils 10 to 12, cores 16 to 18, energizing circuits 20 to 22, and the battery unit 23 are all mounted within a housing 30. The housing 30 is designed to prevent damage that might otherwise occur when the transmitting unit 1 is dropped from an aircraft and, more particularly, to reduce to a minimum the deceleration of its contents that will occur when the unit hits the ground. In this respect, the transmitting equipment may be mounted within the housing 30 by a deformable support 31 that is resilient or that will be compressed, crushed or broken on impact to dissipate to a certain extent the force of impact. The support 31 may, for example, be of a stiff foamed or honeycomb material. Alternatively, the support may comprise a fluid-

filled cylinder and a piston which forces the fluid out of the cylinder on impact. The housing 30 itself may be of a crushable material. Instead, or additionally, the housing 30 might have a fluid-filled bag on its outside that is inflated on release from the aircraft and that is deflated on impact. It will be appreciated that there are many alternative constructions that will reduce damage to the transmitter unit 1. The need for a specially designed housing to reduce the effect of impact damage may be obviated if the transmitter unit 1 is lowered slowly to the ground. This may be done by suspending the unit 1 from a lanyard that is slowly paid out from the aircraft.

If the transmitter unit 1 is to be dropped on to land, the housing 30 is preferably of a tetrahedron shape so as to reduce the risk that it will roll on the ground. Alternative shapes of housing are also possible and the housing could be provided with suitable projections to engage the ground and further reduce the risk of displacement.

If the transmitter unit 1 is to be dropped on to water, the housing would preferably be arranged such as to ensure that the coils remain above the water surface. The shape may be such as to reduce the effects of impact when the transmitting unit hits the water. The housing might also be provided with a heavy keel to reduce the rolling of the transmitting unit in rough water.

It will be appreciated that the housing may have camouflage or brightly contrasting colouring depending on whether or not it is desirable that the housing be conspicuous. The housing may also be designed to present a large or small radar signature as required.

With reference to Figure 3, the receiver unit 4 includes three circular coils 40, 41 and 42 which extend along respective orthogonal axes 43, 44 and 45. The signal induced in each coil 40 to 42 is supplied via screened leads 46 to 48 to respective discriminator units 49 to 51 within a processing unit 52. The discriminator units 49 to 51 each include frequency-selective circuits and are arranged to provide signals at their outputs in respect of the signal strength at each of the frequencies f_1, f_2 and f_3. Each discriminator unit 49 to 51 thereby supplies three sets of signals along lines 53A to 53C. 54A to 54C and 55A to 55C to inputs of a computing unit 56. The computing unit 56 thereby receives nine signals the amplitude of which are measured and used in the computation of the position of the receiver unit 4 relative to the transmitter unit 1.

The nine input signals are used in the solution of nine equations having nine unknowns as explained in greater detail later.

The computing unit 56 calculates the position of the receiving unit 4 relative to the transmitting unit 1 and compares this with a previously selected position. If there is a difference between the two positions, the computing unit calculates the necessary changes to be made to the helicopter controls to correct for this difference and thereby bring the helicopter back to the selected position. Signals in accordance with the changes to helicopter controls are supplied via a line 57 to the aircraft flight control system 5.

The coils 40 to 42 and associated processing unit 52 are mounted beneath the helicopter 3, outside its metal skin 58, and within a protective casing 59 of a plastics or other non-screening material.

The receiver unit 4 and transmitter unit 1 are appropriately calibrated before use. In operation, the transmitter unit 1 is switched on and dropped from the helicopter 3. The pilot manoeuvres to a desired position, within one hundred metres of the dropped transmitter unit 1, and then actuates a button 60 to cause the computing unit 56 to determine the position of the helicopter 3 relative to the transmitter unit. The position determining system then locks on to this position, applying appropriate correction to the aircraft flight control system 5 to maintain this position. The helicopter 3 is preferably maintained in a stable attitude by means of a standard gyro stabilizing control system 70.

A brief summary of the manner in which the position is determined will now be given.

An orthogonal set of axes will be defined by the unit vectors *i, j, k* as shown in Figures 4 and 5. Unit vectors *i, j* lie in a plane parallel to the local ground plane with unit vector *k* pointing vertically downwards. Unit vector *i* is aligned with the required heading of the helicopter 3. The controls of the helicopter 3 determining its heading are assumed to be locked. Changes in the required heading of the helicopter 3 may be corrected by control of a magnetic or gyro compass.

For the transmitter unit 1 the orthogonal coils 10 to 12 are considered as three independent dipoles m_1, m_2, m_3 respectively centred at the point (0, 0, 0). The dipoles m_1, m_2, m_3 are considered to be placed initially along the axes *i, j, k* respectively and then the transmitter unit 1 is rotated through an angle ψ_T about the dipole m_3 axis, then through an angle θ_T about the dipole m_2 axis, and finally through an angle ϕ_T about the dipole m_3 axis. The three angles ψ_T, θ_T, ϕ_T are random and may be time varying as is the case for sea-borne applications.

The dipole m_i has components in the axes set *i, j, k* of m_{xi}, m_{yi}, m_{zi} respectively, that is:

$$m_i = m_{xi} i + m_{yi} j + m_{zi} k \qquad \text{(I)}$$

where i=1, 2, 3.

In matrix notation:

$$\begin{bmatrix} m_{x1} & m_{x2} & m_{x3} \\ m_{y1} & m_{y2} & m_{y3} \\ m_{z1} & m_{z2} & m_{z3} \end{bmatrix} = [-\psi_T][-\theta_T][-\theta_T] \begin{bmatrix} m_1 & 0 & 0 \\ 0 & m_2 & 0 \\ 0 & 0 & m_3 \end{bmatrix} \qquad \text{(II)}$$

where

$$[\phi_\alpha] = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\phi_\alpha & \sin\phi_\alpha \\ 0 & -\sin\phi_\alpha & \cos\phi_\alpha \end{bmatrix} \qquad \text{(III)}$$

$$[\theta_a]=\begin{bmatrix}\cos\theta_a & 0 & -\sin\theta_a\\ 0 & 1 & 0\\ \sin\theta_a & 0 & \cos\theta_a\end{bmatrix} \quad \text{(IV)}$$

$$[\psi_a]=\begin{bmatrix}\cos\psi_a & \sin\psi_a & 0\\ -\sin\psi_a & \cos\psi_a & 0\\ 0 & 0 & 1\end{bmatrix} \quad \text{(V)}$$

and $a=T$.

The non-dimensionalised dipole M_i is given by:

$$M_i=M_{x_i}\,.\,i+M_{y_i}\,.\,j+M_{z_i}\,.\,k \quad \text{(VI)}$$

where

$$M_{x_i}=m_{x_i}/m_i$$

$$M_{y_i}=m_{y_i}/m_i$$

$$M_{z_i}=m_{z_i}/m_i$$

with $i=1, 2, 3$.

Thus in matrix notation:

$$M=\begin{bmatrix}M_{x_1} & M_{x_2} & M_{x_3}\\ M_{y_1} & M_{y_2} & M_{y_3}\\ M_{z_1} & M_{z_2} & M_{z_3}\end{bmatrix} \quad \text{(VII)}$$

$$=[-\psi_T][-\theta_T][-\phi_T] \quad \text{(VIII)}$$

The magnetic field at the position r of the receiver unit 4 where

$$r=xi+yj+zk$$

owing to dipole m_i is given by:

$$B_i=\frac{\mu_o}{4\pi}\,\frac{m_i}{r^3}\left[\frac{m_i}{m_i}-\frac{3(m_i\,.\,r)r}{m_i r^2}\right] \quad \text{(IX)}$$

$$=\frac{\mu_o}{4\pi}\,\frac{m_i}{r^3}\left[M_i-\frac{3(M_i\,.\,r)r}{r^2}\right] \quad \text{(X)}$$

$$\equiv B_{x_i}i+B_{y_i}j+B_{z_i}k \quad \text{(XI)}$$

where $i=1, 2, 3$.

It will be assumed that the orthogonal receiver coils 40 to 42 are aligned with the helicopter axes i', j', k' as shown in Figure 5. The helicopter axes i', j', k' are initially aligned with the unit vectors i, j, k respectively. The helicopter axes are then rotated through an angle ψ about k', then through an angle θ about j', and finally through an angle ϕ about i'; ψ, θ, ϕ being the helicopter's yaw, pitch, roll angles respectively, and i', j', k' being the helicopter's roll, pitch, and yaw axes respectively.

Let V_{1_i}, V_{2_i}, V_{3_i} be the signal strengths induced in the receiver coils 40, 41, 42 respectively owing to the dipole m_i which has a characteristic frequency f_i. Then:

$$\begin{bmatrix}V_{1_i}\\ V_{2_i}\\ V_{3_i}\end{bmatrix}=k_i\,.\,f_i[\phi][\theta][\psi]\begin{bmatrix}B_{x_i}\\ B_{y_i}\\ B_{z_i}\end{bmatrix} \quad \text{(XII)}$$

where $i=1, 2, 3$, and

$[\phi]$, $[\theta]$, $[\psi]$ are defined by equations (III), (IV), (V) respectively.

The nine induced signal strengths are scaled such that:

$$\begin{bmatrix}a_i\\ b_i\\ c_i\end{bmatrix}=\frac{4}{k_i f_i \mu_o m_i}\begin{bmatrix}V_{1_i}\\ V_{2_i}\\ V_{3_i}\end{bmatrix}$$

where $i=1, 2, 3$.

Assuming the helicopter 3 to be stabilized in a horizontal attitude and to be on a heading hold, that is:

$$\phi=\theta=\psi=o \quad \text{(XIV)}$$

then

$$\begin{bmatrix}a_i\\ b_i\\ c_i\end{bmatrix}=\frac{1}{r^3}\begin{bmatrix}M_{x_i}-3(M_{x_i}x+M_{y_i}y+M_{z_i}z)x/r^2\\ M_{y_i}-3(M_{x_i}x+M_{y_i}y+M_{z_i}z)y/r^2\\ M_{z_i}-3(M_{x_i}x+M_{y_i}y+M_{z_i}z)z/r^2\end{bmatrix} \quad \text{(XV)}$$

where $i=1, 2, 3$.

Equation (XV) represents nine non-linear equations in nine unknowns, that is: x, y, z and, from equation (VIII), $\sin\phi_T$, $\cos\phi_T$, $\sin\theta_T$, $\cos\theta_T$, $\sin\psi_T$, $\cos\psi_T$.

These nine equations have an explicit solution. Write equation (XV) in the form:

$$A=\frac{1}{r^3}PM \quad \text{(XVI)}$$

where A is the matrix of the nine scaled measurements made on the receiver coils 40 to 42, that is:

$$A=\begin{bmatrix}a_1 & a_2 & a_3\\ b_1 & b_2 & b_3\\ c_1 & c_2 & c_3\end{bmatrix} \quad \text{(XVII)}$$

$$\text{and } P=\begin{bmatrix}1-3X^2 & -3XY & -3XZ\\ -3XY & 1-3Y^2 & -3YZ\\ -3XZ & -3YZ & 1-3Y^2\end{bmatrix} \quad \text{(XVIII)}$$

where

$$X = x/r \quad \text{(XIX)}$$

$$Y = y/r \quad \text{(XX)}$$

$$Z = z/r \quad \text{(XXI)}$$

noting that

$$X^2+Y^2+Z^2=1 \quad \text{(XXII)}$$

It can be shown that:

$$r^6 = \frac{4}{9} \sum_{i=1}^{3} \sum_{j=1}^{3} [A^{-1}(i,j)]^2 \quad \text{(XXIII)}$$

where $A^{-1}(i,j)$ is the value of the i^{th} row, j^{th} column element of the inverse matrix of A.

Also,

$$\begin{bmatrix} X^2 & XY & XZ \\ XY & Y^2 & YZ \\ XZ & YZ & Z^2 \end{bmatrix} = \frac{4}{3}\{I-([r^3A]^{-1})T[r^3A]^{-1}\} \quad \text{(XXIV)}$$

where T represents the transpose operator and I the identity matrix.

Knowledge of the sign of z, negative for the helicopter 3 above the transmitter unit 1, allows determination of x, y, z from equations (XXIII), (XXIV), (XIX), (XX), (XXI). x, y, z defines the position of the receiver unit 4 relative to the transmitter unit 1.

The above solution involves invoking the orthogonal property of the M matrix (VII) and does not involve solving for the matrix M explicitly. The solution is independent of the orientation of the transmitter unit 1 and, as such, rotation of the transmitter unit in the time interval between each set of nine simultaneous measurements does not affect the determined position of the receiver unit 4. The system therefore has especial advantages where the transmitter unit 1 is floating on the surface of a sea or placed on a non-stationary surface. The system would enable a helicopter to maintain a constant height above a wave during an air-sea rescue operation. The system could be used to advantage in facilitating landing an aircraft on to a moving surface such as on the deck of a ship, the transmitter unit 1 being supported by the moving surface.

The transmitting unit 1 could be arranged to transmit only in response to an activating signal from the helicopter 3. In an alternative arrangement the system could be used for accurately positioning one aircraft relative to another (one aircraft carrying the transmitter unit 1, and the other aircraft the receiver unit 4) such as, for example, for refuelling manoeuvres.

CLAIMS

1. A system for providing an indication of the position of one location relative to another location, wherein the system comprises transmitting means at said one location and receiving means at said other location, wherein said transmitting means includes three electromagnetic coil assemblies and means for energizing each said coil assembly with an alternating signal of a different characteristic, wherein said coil assemblies are arranged to propagate electromagnetic radiation along three respective orthogonal axes, and wherein said receiving means includes three electromagnetic coil assemblies mounted with orthogonal axes, and means for measuring the amplitude of the signal of each characteristic induced in each said coil assembly such as thereby to enable an indication of the position of said transmitting means relative to said receiving means to be provided.

2. A system for controlling the position of an aircraft relative to a surface, wherein the system comprises transmitting means fixed relative to said surface, and receiving means on said aircraft, wherein said transmitting means includes three electromagnetic coil assemblies and means for energizing each said coil assembly with an alternating signal of a different characteristic, wherein said coil assemblies are arranged to propagate electromagnetic radiation along three respective orthogonal axes, and wherein said receiving means includes three electromagnetic coil assemblies mounted with orthogonal axes, means for measuring the amplitude of the signal of each characteristic induced in each said coil assembly such as thereby to provide an indication of the position of said aircraft relative to said surface, and means for monitoring change in said position and supplying control signals to the flight control system of the aircraft in accordance with change in said position.

3. A system according to Claim 1 or 2, wherein each said coil assembly of said transmitting means is energized with an alternating signal of a different frequency.

4. A system according to Claim 3, wherein each coil assembly of said receiving means has associated therewith respective discriminator means, and wherein each said discriminator means provides three sets of output signals in respect of the amplitude of signals received at each frequency.

5. A system according to any one of the preceding claims, wherein said coil assemblies are of circular shape.

6. A system according to any one of the preceding claims, wherein the coil assemblies of said transmitting means are mounted on a deformable support.

7. A system according to any one of the preceding claims, wherein said transmitting means includes a housing in which said coil assemblies are contained, and wherein said housing is of a deformable material.

8. A system according to any one of the preceding claims, wherain said transmitting means includes a housing in which said coil assemblies are contained, and wherein said housing is of substantially tetrahedron shape.

9. A system according to any one of the preceding claims, wherein said transmitting means is arranged so that it can float on a water surface and that said coil assemblies are supported above said water surface.

10. A system according to Claim 9, wherein said transmitting means is provided with a keel below the water surface that is arranged to stabilize the transmitting means.

11. A system according to any one of the preceding claims, wherein said transmitting means is arranged to propagate electromagnetic radiation in response to an activating signal from the receiving means.

12. A method of providing an indication of the position of one location relative to another, wherein each of three electromagnetic coil assemblies of transmitting means at one location is energized with an alternating signal having a different characteristic such that electromagnetic radiation is propagated along three respective orthogonal axes, so as thereby to induce three signals having said different characteristics in each of three electromagnetic coil assemblies of receiving means at said other location and mounted with orthogonal axes, and measuring the amplitude of each of the signals induced in each said coil assembly such as thereby to enable an indication of the position of said transmitting means relative to said receiving means to be provided.

13. A method of controlling the position of an aircraft relative to a surface, wherein the method includes the steps of locating transmitting means on said surface, providing receiving means in said aircraft, energizing each of three electromagnetic coil assemblies in said transmitting means with an alternating signal having a different characteristic such that electromagnetic radiation is propagated along three respective orthogonal axes, so as thereby to induce three signals having said different characteristics in each of three electromagnetic coil assemblies of said receiving means mounted with orthogonal axes, measuring the amplitude of each of the signals induced in each said coil assembly such as thereby to provide an indication of the position of said aircraft relative to said surface, monitoring change in said position, and supplying control signals to the flight control system of the aircraft in accordance with change in said position.

14. A system substantially as hereinbefore described with reference to the accompanying drawings.

15. A method substantially as hereinbefore described with reference to the accompanying drawings.

16. Any novel feature or combination of features as hereinbefore described.

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